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ABSTRACT

This progress report describes the subjects, program and curriculum development, and collected psychological and medical data of the Carolina Abecedarian Project, an intervention program, begun in 1972. The purpose of this project is to bring together a multidisciplinary team of researchers to demonstrate that the developmental retardation of disadvantaged children can be prevented, and to explain how various psychological and biological processes are affected by such preventive attempts. Subjects are selected from families referred by hospital prenatal clinics and other community agencies, and rated according to an experimental "High-Risk Index." Infants are assigned to experimental and control groups, and given family support social work services, nutritional supplements, medical care, transportation, and payment for participation. The experimental group takes part in a planned curriculum (administered throughout the day) consisting of a series of learning activities developed (and evaluated) for children from birth to 36 months. Most of the report is a description of the processes of curriculum development and evaluation and the psychological and medical data collected. (ED)

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The Carolina Abecedarian Project: A longitudinal and multidisciplinary approach to the prevention of developmental retardation[1]

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INTRODUCTION

To be born poor should not subject an individual to a lifetime of intellectual retardation, substandard achievement and ill health; yet all too often it does.

Children who live in poverty disproportionately show developmental retardation (Deutsch and Brown, 1964; Stevens and Heber, 1964). Such deficits may have organic causes, but frequently no organic basis can be found for the developmental retardation. Dunn (1963) observed that "there are no known causes for over 90 percent of the mentally retarded individuals in the United States and Canada today and . . . there are no discernible neurological impairments for 99 percent of the IQ 50-75 group." Moreover, the mildly retarded represent an estimated five million persons or eighty-nine percent of all the mentally retarded (Hurley, 1968).

Hunt (1961) and Bloom (1964) have suggested that the low quality of environmental inputs to the poverty level child may be an important factor in the etiology of retardation. Specifically, children from homes of extreme poverty may be deprived of various early learning experiences relative to children who are economically more privileged.

The environmentally disadvantaged child is part of a disadvantaged family. These families usually have multiple and interacting social, cultural, economic and physical problems which prevent them from achieving a satisfactory level of functioning. The new infant in such a family, no matter how much he may be desired by his parents, represents in certain

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practical ways an added strain on an already stressed family, yet the new infant requires positive family responses if he is to achieve his full potential.

Many types of illness but particularly respiratory illness and its complications interfere with the functioning of children and their families in several ways. The costs of medical care further distress a financially compromised family. These costs include both direct expenses such as physician fees and drugs and indirect costs such as lost wages and transportation to medical facilities. A second effect of illness in the child is the absorption of family energy in nursing care for the sick child which reduces the time available for other tasks such as employment and child development activities. Another effect of respiratory illness is the limit it places on the ability of the child to respond to environmental stimuli. The acute and chronic effects of otitis media on hearing are the most clearly defined and important of these complications. Meningitis is the most serious of the complications of respiratory illness and can result in death, but more commonly causes permanent central nervous system damage. Respiratory illness and its complications are an important element in the constellation of factors leading to poor developmental outcomes.

The complex and interlocking problems of economic deprivation, increased illness and intellectually stifling, in deprived environments present an enormous challenge to those who seek to intervene and improve the chances of the disadvantaged child.

This chapter will describe one such intervention project. The plan of the chapter is as follows: First, a brief overview of previous day care intervention projects, then a description of the Carolina Abecedarian

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Project and the development of its unique curriculum; results of the curriculum evaluation to date and the results of the psychological studies being carried out; description of the mother-infant interaction studies; a prototypic experiment; and a summary of the medical research findings to date.

Previous Day Care Intervention Programs

During the 1960's investigators of child development joined together to press for early intervention programs which had remediation of developmental retardation as their target. Enthusiasm for such endeavors was dashed somewhat in 1969 when the Westinghouse Learning Corporation (1969) published findings which indicated that Project Headstart had achieved far less spectacular results than had been anticipated.

One explanation for the disappointing results may lie in the timing and intensity of the Headstart programs. Perhaps too little program was being applied too late in the child's life to offset the cumulative and pervasive effects of his environmental milieu.

As a response to the Headstart data, two main approaches to early intervention were tried. These were: 1) developmental day care and 2) home stimulation. Results from these programs have recently received independent review by Stedman, et al., (1972) and Bronfenbrenner (1973). Therefore, the literature review will be brief, to set the stage for our project, and only the day care oriented projects will be discussed.

The criteria used to select the projects to be discussed in this introduction were: 1) that children were admitted to the program as infants, 2) that evaluation data were available, 3) that the children in the program were considered by the investigators to be at high risk

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for developmental retardation without intervention, and 4) that the program was conducted in the United States. Collectively, these criteria identified projects concerned with remediation as well as prevention of developmental retardation.

A startling finding emerged when these criteria were applied. Contrary to popular and professional opinion, there simply are not many research oriented projects in this country which focus on the eradication of non-organic developmental retardation. Unfortunately there are even fewer projects which have taken a preventive approach. Further, most of the "first generation" early intervention projects are effectively over because the children are now of school age and active intervention has ceased.

Not long ago, reports from institutions which provided residential care for infants and young children indicated that gross developmental retardation was frequently associated with such care. The pioneering work by investigators such as Spitz (1945), Goldfarb (1955), Bowlby (1959), and Dennis (1957) indicated that institutionalized rearing was associated with cognitive and affective retardation. However, the exact mechanisms and processes whereby such routine care failed to stimulate normal growth and development were not clearly understood.

Investigations by Brody (1951) and Rheingold (1961) indicated that handling and frequent social contact with infants apparently had a therapeutic effect. With the growing realization that institutional care need not necessarily result in developmental retardation, and in light of the recommendation for intervention earlier in the life span set forth in the Westinghouse Learning Corporation Report (1969) concerning Headstart, a number of therapeutic day care programs were started.

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A synopsis of the early research-oriented day care intervention programs was presented by Dittman in 1969. At that time the programs were just barely underway and no systematic data were available on the effects of the programs. Since then, several programs have reported substantial amounts of data, most of which appears quite encouraging, at least with respect to short term increases in developmental status.

Intervention programs for young children which have reported evaluation results in recent years include programs by Caldwell and Richmond (1968), Weikart and Lambie (1969), Robinson and Robinson (1971), and Heber (1971).

Although social, emotional, and physical development are included among the targeted areas for intervention in each of the mentioned programs, it is cognitive development which has received the most evaluation. Indeed, in several cases, cognitive development apparently is the only area of evaluation. One reason for this unbalanced evaluation is that assessment procedures for cognitive development are more sophisticated at present than are assessment procedures for social and emotional development. Further, in many of the programs there simply was no medical component to evaluate or monitor the physical state of the children.

In each of the day care programs the most frequently used means for the evaluation of cognitive development has been periodic administration of standardized tests of early development. The Cattell Infant Intelligence Test, the Bayley Scales of Infant Development, and the Stanford Binet Intelligence Test have been the most frequently used assessment instruments.

Caldwell (1967) has reported that enrollment in the infant program at Syracuse University resulted in IQ gains between 10 and 14 points during the first year of life. Further, it appears from her data that those infants who gained most were from the lower socioeconomic groups.

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Honig and Brill (1970), also at the Children's Center at Syracuse, have reported that 12 month old disadvantaged infants who were attending the Center scored significantly higher than non-attending control subjects on Piagetian tasks for object permanence and means-ends relationships.

Similar to Caldwell's findings, Robinson and Robinson (1971) presented data to show that infants who had been in a day care setting for up to two and one half years evidence increased scores on the Bayley Scales for Infant Development relative to home reared control children. They also found that lower class black children tended to make larger gains than middle class whites.

Weikart (1971) has reported results which demonstrate that early intervention produces an initial spurt in IQ performance for children in a preschool setting; but, after intervention ended, the experimental and control groups' scores tended to converge by third grade. However, the children in the Perry Preschool Project were not admitted to the program until they were three years old and had been selected on the basis of low developmental level (IQ 50-85) in the beginning. Thus the Perry Project is not as directly relevant to the issue of prevention of developmental retardation as it is to remediation of low level functioning.

The early intervention project which has generated the most interest recently is Heber's (1971) project in Milwaukee. It is quite understandable why this project has attracted such great attention. Without question, Heber's project is the most relevant project to the issue of preventing mental retardation conducted thus far. It is also the project which has reported the most systematically collected evaluation data.

The basic rationale for Heber's work comes from a survey reported by him in 1968 (Heber, et al., 1968). With reference to poverty and retardation he reported that:

. . . it is not just the "poor" or "lower classes" who contribute the "cultural-familial retardate," it is certain families belonging to a certain group within this population who make the largest contribution. It is a relatively small percentage of families within the deprived economic groups which contributes very heavily to the high prevalence of "cultural-familial" retardation.

Heber substantiated this claim by reporting the results of a survey completed in a slum of Milwaukee. His results showed that mothers with IQ's below 80 contributed 78.2% of the children with IQ's below 80. Further, children whose mothers had IQ's above 80 tended themselves to have IQ's that remained relatively constant (low 90's) between 13 and 168 months of age. Children whose mothers had IQ's below 80 evidenced a progressive decline from about 95 to about 75 over the same time span.

With these results in hand, Heber began an intervention program for a group of 20 infants whose mothers had IQ's less than 75. Twenty matched children served as control subjects.

The experimental group children were initially visited in their own homes for several months after birth until a relationship of trust could be established with the mothers. As soon as that was achieved, the infants began attending the Infant Education Center where the experimental infants were provided an intensive social program which began shortly after birth. Support provided for the mother included occupational training in addition to training in home-making and baby-care techniques.

The children were in the Center from morning to late afternoon. Although understandable, it is unfortunate that there does not exist a

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detailed description of the curriculum to which the children were exposed. (Heber's project is similar to other intervention programs in this respect.) It is unfortunate in that we are left without a replicable description of one of the most important independent variables in the intervention program.

Heber is not unaware of this limitation. Speaking in a slightly larger, but relevant, context he has noted that:

> We must recognize, of course, that the mass stimulation of both babies and mothers will not permit identification of the specific aspect responsible if the "high-risk" experimental babies do show a normal intellectual development. But it is our belief that it is a more efficient research strategy to ask, first of all, whether intellectual development can be influenced by massive intervention into their social environment. If this can be demonstrated, those factors specifically responsible can be brought under subsequent investigation.

Although Heber's results have been criticized on the basis of methodology and treatment specification (Page, 1973), they are nevertheless spectacular. The experimental subjects' mean IQ scores ranged from slightly above 120 at 42 months to more than 125 at 45 months. The difference between the experimental and control group at 45 months was a staggering 33 points, even though both groups had been tested equally frequently. However, in light of the methodological flaws in the Heber project, replication of his results are certainly needed before they are totally accepted as valid.

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Strengths and Limitations of the Day Care Intervention Data

The most encouraging suggestion from these studies is that children need not necessarily be trapped into the cycle of retardation associated with poverty. In fact, as Heber's results most compellingly point out if they can be replicated, the possibilities for change and growth may be even more dramatic than anyone would have dared hope only a few short years ago.

However, even if Heber's results are valid not all is settled. Serious questions about center-based intervention that remain unanswered, and which are being addressed in the project currently underway at the Frank Porter Graham Center, include the following:

1. Precisely what services were performed for families in the experimental and control groups? For example, was the day care component of the project the only differentiating factor between the groups or were there differences in the availability of social work services, adequate nutrition, and good medical care as well?

2. What specific curriculum materials were used in the intervention program? How were they selected?

3. Was the child's relationship to his mother and other family members affected by participating in the program?

THE CAROLINA ABECEDARIAN PROJECT

In the fall of 1972 the Carolina Abecedarian Project was begun as an attempt to bring together a multidisciplinary team of researchers which would address itself both to demonstrating that developmental retardation could be prevented, and to explaining how various psychological and biological processes were affected by such preventive attempts.

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In the next few pages we shall describe the subject selection process and briefly describe the major programmatic elements of our project.

Selection of Subjects

North Carolina Memorial Hospital, the University of North Carolina's teaching hospital, is the primary referral source for potential subjects for the project. Through its various prenatal clinics pass most of the expectant mothers of Orange County who are likely to meet the criteria for inclusion into our sample. In addition, liaison is maintained with the Orange County Department of Social Services and other community agencies which are likely to have contact with potentially eligible families.

Once a family is identified as being potentially eligible and has had its name referred, the supervisor of the project's infant nursery establishes contact with that family and arranges to see them at their home for an interview to explain the project and to determine if they are interested in participating, if invited to do so. If the supervisor determines that the family potentially meets the criteria for inclusion into the program, the expectant mother is invited to the Frank Porter Graham Child Development Center, where the project is being conducted, for a series of interviews. These interviews are designed to assess her attitudes toward child rearing practices and to gather detailed background and specific demographic information about the family.

One purpose of these interviews is to rate the family on an experimental version "High-Risk Index" which is shown in Table 1. This index was constructed before beginning the Abecedarian Project. Weights were assigned to the various factors based upon our "best guess" of their

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relative importance. Because there was and is little epidemiological data concerning the factors linked to developmental retardation it was impossible to assign empirically derived weights to each factor. However, it is hoped that as the sample families are followed it will be possible to derive empirical weights through multiple regression analysis which can be used to predict developmental status more precisely.

Insert Table 1 about here

After target children are born, qualifying families are pair-matched on sex of the child, maternal IQ, number of siblings, and high-risk index scores, and are randomly assigned to either the experimental or the control group. Table 2 contains a summary of the demographic and psychological characteristics of the first two cohorts of children admitted.

Insert Table 2 about here

To date, 59 families have been offered membership in either the experimental or control groups and 58 have accepted and all remain in the program except two families, each of whose infant died in the first year of life. One child who died was diagnosed as a "crib-death" and the other child died from heart failure secondary to endocardial fibroelastosis. One child had been in the experimental group, and one child had been in the control group.

The Program

Both the experimental and the control subjects receive the following services:

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1. Family support social work services. On a request basis from the parents and from routine visits to all families, the Abecedarian Project seeks to provide all families with goods, services, or guidance in such areas as legal help, family planning, obtaining food, obtaining clothing, or any other services which will help to keep the families intact. However, no advice is given to any of the families concerning how they treat or interact with their children. The only exception to this procedure is that standard well child counseling is provided during routine health checks which are done on a schedule slightly modified from the recommendations of the American Academy of Pediatrics.

2. Nutritional supplements: Each child in the experimental group receives the bulk of his nutrition at the day care center. Breakfast, lunch, and an afternoon snack are served each day. To control for nutrition as one explanatory variable in observed differences between the experimental and control groups, the control group receives free formula on an unlimited basis for as long as they use it and plans are underway to provide other nutritional supplements beginning in the second year of life.

3. Medical care: All medical care for the Center-attending children is provided by the Frank Porter Graham Center medical staff. Free medical care for the control children is provided by the Frank Porter Graham Center staff and two university affiliated clinics. Thus, all children have available adequate medical care and the project maintains records on all care delivered.

4. Transportation: Transportation to and from the Center is provided for all subjects participating in the project.

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5. Payment for participation: All mothers are paid for participating in any psychological evaluations.

6. Disposable diapers are provided free to the control subjects as an inducement for continuing participation.

The experimental group differs from the control group in that the former receives a planned curriculum administered throughout the day. The day care component of the Center operates from 7:45 a.m. to 5:30 p.m. each weekday.

The Curriculum

The curriculum component of the Abecedarian Project seeks to develop and evaluate a series of learning activities for children from birth to 36 months of age. Collectively the activities are called the Carolina Infant Curriculum. As the activities are developed and used, they act as the major intervention treatment for the Project. Detailed records of the activities and sequences prescribed for each child are maintained. This concern over specificity is in response to a major problem in most of the previous infant intervention projects: a vague or unspecified treatment.

The curriculum development process for the Carolina Infant Curriculum consists of three steps: (1) objectives are synthesized or selected, (2) curriculum products are developed, (3) the curriculum products are evaluated. In a fourth step not included in this project, the curriculum will be disseminated with accompanying training packages.

Synthesis of Educational Objectives

The present system for synthesizing curriculum goals has its origins in the theoretical position presented by Ralph Tyler (1950) and later

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elaborated by others. Within this framework, curriculum objectives are seen as the product of the interaction of a number of sources or factors. The present formulation identifies the interacting sources as (1) consumer opinions, (2) developmental theory, (3) developmental facts, (4) adaptive sets and (5) high risk indicators.

The five sources from which this system synthesizes curriculum objectives are pictured on Figure 1. The first source of curriculum goals is consumer opinions. Very young children are of course the consumers of the infant curriculum. Through interviews, the hopes and aspirations parents have for their children may be determined. Without this knowledge a project might proceed down a blind alley, producing a program that would in the end be rejected by the public it seeks to serve.

Insert Figure 1 about here

The second source for deriving curriculum goals is developmental theory, largely that of Jean Piaget. The theory can be pictured as a ladder. On any rung of a ladder, one can look backward to see how the current status was arrived at or forward to see which steps are next. The theory helps the curriculum developer do just that.

The third source, developmental facts, acts as a background against which the developmental theory is viewed. Developmental facts provide a great amount of detail with which to supplement the theory. In this project, facts have been gleaned from 30 sources, including Bayley, Buhler, Gesell, Lenneberg, McCarthy, Shirley and others. The facts are arranged in four broad developmental areas: language, motor, social/emotional, and cognitive/perceptive.

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Of all the sources of educational objectives, the most important may be adaptive sets. This is especially true for the Carolina Infant Curriculum since it is created with the implicit purpose of changing or enhancing the adaptive sets of the infant. The child with strong adaptive sets has the tendency to more forward (for example, to explore rather than withdraw, to persist rather than give up easily). Therefore, adaptive sets can be thought of as that class of behaviors which predictably generate age-appropriate success. More simply, adaptive sets are "winning strategies" and are shown as an arrow moving along the ladder. The process of selecting statements of adaptive sets for this project, it should be clear, relies on professionally informed value judgments as well as relying on research findings. Since value judgments exist in any process of selection of educational objectives, the Carolina Infant Curriculum Project attempts to identify this bias by making it overt and subject to examination. For example, the following are among the statements of adaptive sets in this project. All of these behaviors can be thought of as being exhibited to an age-appropriate degree with extensive use desired by age 24 months:

1. Uses adults as resources
2. Controls his immediate environment
3. Uses both expressive and receptive language extensively
4. Detaches self from mothering adult and explores independently
5. Exhibits high attention behavior
6. Responds frequently with positive approach to new object or person
7. Easily adapts to changes in environment
8. Executes multi-step activities
9. Anticipates consequences

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10. Explores extensively with the distance receptors
11. Uses cooperative behavior
12. Uses basic sharing behavior (showing, giving, pointing)
13. Generates specific instances of a behavior by guidance of a general rule
14. Relates strongly to the family and identifies with the subculture group

The final source of educational objectives is an awareness of high-risk indicators coupled with an effort to eliminate these. The indicators are seen as asterisks or "warning signs" along the developmental continuum. To a substantial degree the high risk indicator behaviors are the mirror image of the adaptive set behaviors. That is, the class of behaviors called high risk indicators could be thought of as maladaptive sets, or perhaps "losing strategies". Since this infant curriculum is designed especially for children who are at high risk of developmental retardation, and since research is beginning to document some of the behavioral deficits which high-risk children consistently develop, it is hoped that these deficits (here called high-risk indicators) can be anticipated through educational objectives which are basically preventive.

In using the present system of synthesizing educational objectives, detailed lists of facts and information have been compiled under each of the five "source areas" and arranged on a large wall chart. Since these five areas are thought of as interacting sources, all five are utilized in the synthesis of each educational objective. By uniting a piece of information from each of the five areas, a single educational objective is created.

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Curriculum Product Development

Once a specific educational objective has been created, the curriculum team moves on to product development. Using their knowledge of children, the team generates ideas for products (sometimes called items or activities) to elicit the behavior specified in the educational objective. The curriculum product is often a game for adult and infant or a toy with special properties. A particular idea for an item is developed further if it meets these criteria:

(1) It is a reasonable task that is conceptually related to the five sources of educational objectives.

(2) It is capable of being presented by persons of modest education.

(3) The child or teacher has observable output behavior, which allows performance to be measured.

(4) The cost associated with the item is minimal.

A one page parent-and-teacher guide sheet, written in simple language and using photographs to illustrate important points, is developed for each product. A sample guide sheet is provided in Figure 2.

Insert Figure 2 about here

The development of parent and teacher training material parallels the curriculum product development. The parent and teacher training materials will consist of slide tapes and pamphlets for a series of training sessions. Parent training will be designed to increase parent skills in (1) use of reinforcement, (2) use of modeling, (3) providing adequate language stimulation, and (4) providing variety of experience. The training sessions

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will provide the parents new knowledge in the area of child development and will attempt to influence parent attitudes regarding early education.

Curriculum Use

The curriculum is prescribed on an individual basis. The assignment of activity items to each child is based on the items' age-appropriateness and on staff observations recorded on the child's personal developmental chart. The chart is a chronological listing of developmental facts in four major areas drawn from accepted sources. When a particular behavior of a child such as "inspects own hands" is observed for the first time, the date is noted beside that fact on the child's chart. In addition to providing a written progress record, the chart helps the staff to see whether the child is developing satisfactorily in all areas. It also makes it possible to prescribe activities which are needed by that particular child but which might not ordinarily be assigned to one in his age group.

Staff sessions both formal and informal are held frequently. These provide opportunities for all members to become aware of any special problems concerning an individual child or the group. Meetings are also a vehicle for discussion of appropriateness, purposes, and techniques involved in the use of the curriculum items. These sessions serve as an important part of the informal training for the less experienced members of the staff.

Approximately every two weeks for the infants and at longer intervals for the older children new curriculum item assignments are made. These sometimes include extension of previous items if it is felt necessary. For each child a record is kept of the item assignments and of the dates on which the items are introduced to him. Daily tallies are also kept for

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each activity done with each child. This ready record enables the staff to be sure that no one child's curriculum activities are neglected or are unevenly administered. These tallies provide data also for determining the effectiveness of separate curriculum items.

Curriculum items for the youngest group are often a part of the general caretaking routine. As the child grows older the activities become more discrete. Curriculum activities are scheduled typically for the infants during the period after breakfast and bathing and before morning naps. They are scheduled again between lunch and afternoon naps. As individual schedules change, adjustments are made in activity times. The toddlers and older children typically are involved in curriculum activities from mid-morning until lunch and again after naps in the afternoon. In addition to these specified arrangements, the curriculum activities are adjusted to inside or outside, play, dressing, eating, etc., so that when it is functioning properly, the curriculum permeates the whole day.

RESULTS

To evaluate the medical, psychological and educational consequences of this intervention program, a wide variety of experimental procedures, interviews, standardized tests, attitude assessment measures, controlled naturalistic observations in laboratories, and home observations are repeatedly used. A sampling of the results from each of these procedures will be presented in an attempt to represent the style of the inquiry as well as to summarize some of the salient findings to date. However,

it must be remembered that the project is still a young and expanding one. Most of the measures to be discussed are designed to be accomplished within a repeated measures design and only beginning point evaluations exist on some variables. Therefore, these results must be regarded as tentative and preliminary.

Curriculum Evaluation Data

Basic research focuses on the acceptance or denial of various hypotheses, whereas evaluation focuses on the extent to which particular program objectives have been met. The two major objectives for the curriculum component are seen as production and formative evaluation. Summative evaluation, a third objective, will be accomplished through future field testing.

Production Evaluation

The initial task of evaluation is to verify that the system of production is adequate and is in fact working. A review and personal judgment technique by a jury of knowledgeable professionals was chosen for this task. A first step in the evaluation-by-review process was carried out during 1972-1973. Several professionals in the area of infancy visited us at our request and reviewed the curriculum system and other aspects of the infant research program. As a result of this review, revisions were made in the curriculum system and several ideas were added to the proposed evaluation plans.

A second, more detailed review is proposed for 1974-1975 when a second group of nationally recognized professionals will be invited as a panel or jury to spend several days together examining the curriculum and the actual materials involved and to prepare a written evaluation report. The panel will be asked to indicate whether the curriculum is consistent

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with our best knowledge of child development and represents a reasoned program of infant stimulation.

As of March, 1974, over 170 curriculum items had been produced and formative evaluation data collected on more than half of these.

Formative Evaluation

An essential task of evaluation is to provide corrective feedback while the curriculum materials are still in a formative stage. It is especially in the formative evaluation of each individual curriculum product or item that the experimental group makes a great contribution to this project. The work described below would be extremely difficult on a field basis.

Data are collected by both the teacher and an observer in the formative evaluation strategy of the Carolina Curriculum. Data forms are filled out when an item is first used with a child and again approximately two weeks later. Five areas of information are graphed (as percentages) for each curriculum activity and are entered into the decision to accept, modify or reject the activity. Typically, a 75% performance level on four out of the five areas is taken as satisfactory evidence for accepting the objective and activity. Two activities will be used to illustrate the outcomes of this type of evaluation.

The simple activity "Holding the Baby for a Better Look at Things" was used with 13 infants at an average age of 2.6 months. The objective was "to increase headlifting and looking behavior when the infant is held at the shoulder position". Teachers said that 75% of the infants were doing better after approximately two weeks experience with this activity. Indeed, this is verified by the observer's timing of changed behavior.

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In this case the target behavior was "a headlift plus visual attention to immediate surroundings".

Insert Figure 3 about here

This behavior increased 105% over the two week period from an average of 53 seconds to an average of 109 seconds. Observations of the teachers' behavior showed that the activity and goal were clear since implementation was rated as successful 97% of the time. During only 61% of the sessions did the observer rank the teachers' language as adequate (i.e., "Talked to child during most of the activity" or "Talked to child almost constantly"). While the goal is for a 75% rating in language on most activities, this lower percent makes sense since the infant and adult are not necessarily facing each other during this activity. Language stimulation is certainly of less importance in this activity than in most others. Finally, 100% of the teachers who used this activity expressed a positive opinion of it. Since the guideline of a 75% rating in four out of the five data areas was met, the activity and goal were accepted into the curriculum. It should be stressed that the decision-making process depends heavily on informed professional judgment, and that additional observations may justify overriding the guidelines in specific instances. It should also be repeated that the process being described here is formative evaluation (which provides information to help the program developer make decisions) and not research (which tests the validity of hypotheses).

A second activity, "Choosing Between Big and Little", used with 8 infants of an average age of 10.8 months, presented a less positive profile. The target behavior observed for change was "to pick up the requested

member of a large-small set of two items". Even though teachers again said 75% of the infants were doing better after two weeks, the teacher judgment was not confirmed by the number of correct choices counted by the observer (Figure 4). In fact, there was no increase in the infants' average number of correct choices of the big and little objects. It would appear from the implementation (79%) and language ratings (94%) that the teachers were using the activity satisfactorily.

Insert Figure 4 about here

The clue is perhaps in the 60% positive teacher opinion of this activity. Teachers probably disliked this activity because it was too difficult for many children at this age. As a result, they may have "gone through the motions" of teaching it without that special enthusiasm that is a necessary part of any activity's success. The activity and goal were rejected from the curriculum for this age level. In other instances, an activity may not be rejected but be sent back for revision and retesting.

Feedback which aids in the on-going decision-making process is essential to the curriculum developer. By making informed decisions while the goals and activities are in a formative stage, the developer can move the process forward through a series of small corrections with less chance of any large surprises at the end of the road.

Psychological Data

Bayley Scales of Infant Development Results

The Bayley Scales of Infant Development are administered every 3 months beginning at three months of age. Results are available only for the first 28 infants admitted to the program for the full first year's evaluation at present.

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Inter-rater reliability on an item by item analysis was 91%. The mean Mental Developmental Index for the experimental group during the first year was 107.1 versus 100.8 for the controls. This difference is significant by t-test comparison ($p < .05$); similar comparisons in the Psychomotor Developmental Index revealed means of 108.3 for the experimentals and 98.7 for the controls. Again this difference is significant ($p < .05$) by t-test comparison.

Attitudinal Results

Relatively little is known about how mothers in the lower socio-economic groups perceive themselves or how such mothers might differ in attitudes toward children from other segments of the population.

In an attempt to generate data relevant to this issue Emmerich's (1969) adaption of the Parental Attitudes Research Instrument (PARI) and Rotter's (1966) Internality-Externality Scale (I-E) were administered to 14 experimental and 14 control group mothers in the first year of the program. To aid in understanding the responses of this group to the two instruments, the same instruments were administered to a randomly drawn comparison group of 34 mothers from the same community who had infants born the same year and whose infants were matched for age.

The findings were that mothers in the project, whether in the experimental or the control group, differed significantly from the comparison group on both instruments. On no comparison did the experimental and control mothers differ significantly. The lower class mothers had a mean score on the I-E scale of 11.21 (higher scores indicate more perceived external locus of control). The comparison group had a mean score of 8.55, ($p < .02$). The finding that lower class black women describe themselves as more externally controlled is expected; but it is of interest that this female group appears

to be more extreme in this regard than do lower class male groups of comparable age (Lefcourt and Ladwig, 1965).

Emmerich's (1969) version of the PARI assesses three factors: Authoritarian Control, Democratic Attitude, and Hostility and Rejection. The lower class mothers described themselves as more authoritarian ($p < .001$), less democratic ($p < .001$), and less hostile and rejecting ($p < .01$), all by t-test comparisons. It has been suggested that Authoritarian Control may be associated with ineffectiveness in the parental role (Emmerich, 1969). That lower class mothers describe themselves as less democratic perhaps goes along with the tendency toward behavioral suppression of children, seen in their more authoritarian orientation. The finding that this group of lower class mothers describe themselves as less hostile and rejecting is interesting considering that many of them face more hardships as parents than do parents in the comparison group. This factor includes scales on marital conflict, rejection of the homemaking role, and irritability. The findings may document a tendency for the more educated women in the comparison group to reject the homemaker-mother role, or perhaps the disadvantaged women tend to romanticize the wife-and-mother image.

The Rotter and PARI did not correlate significantly with each other for two of the three factors, but I-E and Democratic Attitude were negatively correlated ($r = -.37$, $p < .01$). This suggests that parents who feel that they are more in control of their own destinies may wish to foster the same sense of autonomy in their children.

Inventory of Home Stimulation Results

It is assumed that certain environmental experiences are crucial to the social and cognitive development of children. An Inventory for Infants,

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Home Observation for Measurement of the Environment (HOME), was used to sample certain aspects of the quantity and quality of social, emotional and cognitive support available to a young child (birth to three years) within his home.[2] This Inventory was administered to both experimental and control mothers and to a group of mothers chosen at random from the same community. The random sample was chosen to match the high risk infants on age, sex and parity. Mean age of the infants, across groups, at the time HOME was administered, was 6.8 months, with a range from 3 1/2 to 9 1/2 months. All infants were seen in their own homes with the mother present. Three interviewers collected the data. Mean inter-rater item reliability was 92%.

The HOME Inventory consists of six factors, with the items comprising the factors being scored on the basis of direct observation and interview material. The factors include: Emotional and Verbal Responsivity of the Mother, Avoidance of Restriction and Punishment, Organization of the Physical and Temporal Environment, Provision of Appropriate Play Material, Maternal Involvement with the Child, and Opportunities for Variety in Daily Stimulation.

Several demographic variables of the group were also compared along with the HOME factor and total scores; these included maternal age, family income, paternal education, and a Human Density ratio consisting of the number of persons living in the home over the number of rooms.

A multivariate analysis of variance (MANOVA) was computed using the ten factors mentioned above as separate dependent variables and the three groups as independent variables. The experimental and control families did not differ significantly from one another on any of the ten variables.

However, when the experimental and control groups together were compared to the random sample, each of the ten comparisons was significant at $p < .001$ with the random sample consistently scoring in the higher direction. Table 3 presents a summary of the analysis:

Insert Table 3 about here

Mother-Infant Interaction Results

One of the major issues of very early day care intervention is that the mother-child relationship may be significantly altered by the young child being away from the mother for relatively long periods each day.

In this section we will report data on 12 experimental dyads and 13 control dyads who were seen in the first year of the program. The experimental subjects and the control subjects were matched on chronological age and sex at the time of taping. The infants ranged in age from 3.5 to 9.5 months of age with a mean of 197 days.

The videotaping took place in an experimental room at the FPG Center which had a videotape camera with a wide angle lens mounted in one corner. The room was approximately 9 feet by 11 feet and contained a couch, a chair, a television and a small table and lamp as well as a small crib. Toys and magazines were also available.

The mother was instructed that we were examining the activity levels of children when they were near their mother in a new place and that they were to respond to their child just as they would at home. The camera was pointed out to the mother and the experimenter left the room and videotaping began.

The following frequencies and durations of mother and child behaviors were recorded onto an Esterline-Angus event recorder by two independent observers after the session.

Mother's Behaviors

1. Talks to child
2. Demonstrates toys to child
3. Touches child
4. Holds child
5. Interacts with child without toys
6. Reads to self
7. Reads to child
8. Television on

Infant's Behaviors

1. Vocalizes
2. Fusses/cries
3. Eats and/or sleeps
4. Plays with toys by self
5. Interacts with mother and toy simultaneously
6. Being in the crib
7. Being on the couch with the mother

Mean inter-observer reliability across all categories was 97.6% with a range from 91% to 100%. Two tailed t-tests were calculated for each of the observed behaviors comparing the experimental and control dyads. Table 4 provides a summary of the significant differences between the experimental and control dyads.

Insert Table 4 about here

It will be noted from that table that Center-attending infants vocalize more and cry less than do control infants. Further, the experimental children interact more with their mothers both with and without toys as props than do the control children. It should also be noted that there

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seems to be a better "match" in time between the infants' vocalizations and the mothers' vocalizations which might partially explain the overall superiority of the experimental group's vocal output.

Finally, correlations of each of the 15 variables with age revealed only three significant relationships. These were: (1) that age was negatively correlated with the mother's demonstrating toys ($r = -.51$, $p < .01$), (2) that age was negatively correlated with the mother's touching the child ($r = -.56$, $p < .004$), and (3) that age was negatively correlated with the mother's interaction with her infant without toys ($r = -.46$, $p < .02$).

Thus, in sum, it appears that participating in the day care program seems to affect the mother-child relationship in an enhancing manner rather than in a detrimental way, at least in the first year of life and with high-risk infants as subjects.

Results from Prototypic Experiments

A wide variety of naturalistic observations in the nursery and controlled laboratory experiments are conducted to specify naturally occurring conditions or to test basic hypotheses concerning the intervention philosophy.

One example of a controlled naturalistic observation will be presented to give the reader a flavor of this style of observational research.

Finkelstein, O'Brien, and Ramey (1974) have noted that the belief that toys are desirable and should be provided for young children and infants is widely accepted by adults and other adult caretakers. With respect to intellectual development, a great many developmental psychologists, if not all, would support this point of view. For example, Piaget (1970)

states that during infancy and early childhood, objective knowledge is acquired through direct actions on objects. However, a theoretical position concerning the influence of toys on social development could not be found in the literature. In addition, the few relevant studies in the literature have not examined the influence of toys on a sufficiently broad set of behaviors in the normal caretaking environment of the infant.

The studies reviewed, including those by Rheingold and her colleagues (Rheingold, 1973; Rheingold and Samuels, 1969; Corter, Rheingold and Eckerman, 1972), and Maudry and Nekula (1939) led to our conclusion that in the first year of life toys do not facilitate social interactions. Rather, it seems that toys compete with social objects for the infant's attention. When observed in a laboratory setting with his mother and novel toys, the infant spent more time with toys than with his mother. Similarly, when observed with a peer, positive social responses were more likely to be directed towards the toys than the peer.

Beginning in the middle of the second year of life, toys are used to establish and maintain social contact with peers (Maudry and Nekula, 1939) and adults (Rheingold, 1973). Children have been observed giving or showing toys frequently to peers or adults. An important question, to which previous studies have not addressed themselves, concerns the effects of familiar toys on infants' behaviors in familiar environments. This experiment is a study of the influence of toys on the behaviors of infants in their normal rearing environment using methods closely approximating naturalistic observations.

Method: Subjects. Six of the 14 infants attending the Frank Porter Graham Child Development Center's Day Nursery who were closest in age were selected to be observed in this study. The sample included four

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black, female infants and two black, male infants. The infants ranged in age from 6.5 to 11.5 months and the mean age was 9.5 months.

Setting: The observations were made in the nursery which consists of two bedrooms, two playrooms and a large central hallway that connects the rooms. The bedrooms contain cribs and the infants were in these rooms only when they were being put to bed or were asleep. When awake, the infants were usually in one of the playrooms or the hall. Four or five teachers, the other infants and numerous toys could be found in these areas as well as diapering and feeding facilities.

Procedures: The experiment was performed in three phases, each lasting two weeks. In each phase, three infants were observed on Monday, Wednesday and Friday during the first week and on Tuesday and Thursday during the second week. The other three infants were observed on the reverse schedule. Each subject was observed individually for five minutes during each of four daily observation periods beginning at 9:30 a.m., 10:30 a.m., 11:30 a.m., 12:30 p.m. The order in which subjects were observed was determined from a table of random numbers for each hourly period.

During the first two phases, two experimenters observed the infants at a distance of approximately three feet from each other. The infants were observed from a distance of approximately six feet.

Within the observation period for each subject, five-second observation intervals alternated with five-second periods for recording the occurrence of the following behaviors:

1. Vocalization--discrete voiced sounds that were not sounds of distress

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2. Crying or Fussing--voiced sounds that were either loud, high-pitched and continuous or soft, low-pitched and discrete indications of distress
3. Manipulating Objects--hand contact with non-human objects that could be moved
4. Sleeping
5. Locomoting by Oneself--crawling or walking with aid and not including being carried
6. Adult-Child Contact--visual regard or tactile contact between an adult and infant initiated by either the infant or adult. Also included in this category were adult vocal responses directed to the infant. Those contacts initiated by adults that were necessary to accomplish feeding, diapering or dressing were not recorded.
7. Child-Child Contact--for this measure, any infant other than the subject was considered equivalent to an adult and the definition of adult contact was used.

A subject's score on each dependent variable was the number of five-second intervals in which the behavior was observed during each phase. In each phase, there were 600 five-second observation intervals.

Observer reliability was computed separately for each behavior of each subject in the second phase of the experiment using product-moment correlations. The median reliability coefficient was .96.

Phase I: During Phase I, baseline data were collected for each of the seven measures. The observations were made while all the commercially produced or home-made toys normally available were present. No attempt was made to alter the natural situation, and all the infants were free

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to move about as they pleased. The teachers were not given any instructions by the experimenters, nor were the teachers aware their behavior was being recorded until after the experiment was completed.

Phase II: In the second phase of the experiment, 15 minutes prior to each hourly observation period, all the toys were removed from the nursery and were not returned until after the three subjects were observed. In all other ways, the procedures for observations were identical to those used in Phase I.

Phase III: The final phase was a repetition of the baseline conditions of Phase I. The toys were again present in the nursery at all times.

Data Analysis and Results: The first step in the data analysis was to randomly assign the subjects to two groups of three each in order to determine which observer's records would be used in the data analysis. One observer's records were used for the subjects in Group 1 in Phase I and for Group 2 in Phase II. The data for the other subjects were obtained from the records of the second observer in Phase III. There was only one observer whose records provided the data for all subjects.

The data for each dependent variable were analyzed in a separate analysis of variance with repeated measures for the effect of phases, or conditions. The Box (1954) correction factor was used to adjust the degrees of freedom in order to obtain an estimate of the probability of a Type I error that is less affected by violations of the variance-covariance assumptions required for repeated measures (McCall and Applebaum, 1973).

Results from these analyses indicated significant effects of toy presence on only three of the seven variables. These results are graphically presented in Figure 5.

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Insert Figure 5 about here

The variables were:

Vocalization	$F_{(1,7)} = 7.806$, $p < .05$
Child-Child Contact	$F_{(1,7)} = 12.162$, $p < .025$
Adult-Child Contact	$F_{(1,6)} = 10.415$, $p < .025$

Post-hoc means comparisons using the Newman-Keuls procedures (Winer, 1962) were performed separately for each of the three variables to clarify the effects of the manipulations. The results indicated that toy removal was associated with a significant decrease in the frequency of vocalizations ($p < .05$) and a significant increase in the frequency of child-child contacts ($p < .05$). Both of these changes continued when the toys were again continuously available in Phase III.

When the toys were removed, adult-child contacts were significantly more frequent than during either baseline phase ($p < .05$). The baseline measures of adult-child contact made before and after the toy removal phase were not reliably different.

The influence of toys on the behaviors of infants in the natural caretaking environment as observed in this study is similar to that observed in laboratory settings in earlier studies. Rheingold and Samuels (1969) observed that infants placed in a relatively barren laboratory room with their mothers and toys spent most of the time manipulating the toys. Infants in the same setting without the toys spent as much time manipulating objects in the room such as their mother, a doorstop or the drapes. In the present study, when the toys were unavailable the infants found other objects to manipulate, such as tissue boxes or jar caps.

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The greater frequency of contacts with the teachers and other infants observed when the toys were not present in Phase II is also consistent with the observations of other investigators who were previously mentioned. It was interesting to find that peer contacts continued to occur more frequently in Phase III when the toys were again present during the observation periods. It is possible that peer contacts during Phase II were sufficiently rewarding to maintain their higher frequency of occurrence even when the toys were also available.

In the first year of life the child does not incorporate toys into social interactions, and in the presence of toys the frequency of social contacts is, in fact, less than in their absence. If the development of social competence is advanced by frequent interactions with adults and peers, then, at this age, toys may not facilitate social development.

The earlier studies in the literature suggest that the infant uses toys as sources of novel and complex stimulation alternative to that provided by adults and peers. The toys used in this study had been present in the nursery for at least three months prior to the experiment and were not likely to have been novel objects for the infants. Still, novelty could have been an important factor if it is also defined by the new ways the infants were developing to respond toward the toys as time passed. However, in order to understand fully the influence of toys on social development, it is just as important to study how the adult uses those toys. Our informal observations lead to the impression that adults use them as alternatives to providing personal attention. It is likely that adults caring for infants have learned from past experience that an infant left alone with no objects to manipulate will soon begin to cry (e.g., Rheingold and Samuels, 1969) and that an interesting toy will substitute

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nicely for social stimulation. We observed that the teachers almost always placed a toy before an infant before stepping away. In this study, the behaviors of the adults present during the observations were not restricted in any way by the experimenters. When the toys were not available, it is, therefore, possible that the adults spent more time with the infant in anticipation of their usually annoying cry if left alone. This assumption that the teachers contributed to the observed increase in the frequency of adult-child contacts would also be consistent with the decrease in frequency of adult-child contacts when the toys were again continually present in Phase III.

Whereas toys may facilitate intellectual development in the first year of life, it is not clear that this is also true for social development.

Medical Data

Physical illness in any member is an added burden to the disadvantaged family. Respiratory infectious disease is the most common acute illness of man and is the major cause of morbidity in families. The preschool child has approximately eight respiratory illnesses each year and is a frequent source of infection for other family members (Dingle, et al., 1964). The burden of respiratory disease is not limited to the disadvantaged family, but these families have fewer resources with which to cope with the consequences of illness. In addition, there is much evidence that serious illness occurs with greater frequency in the socioeconomically deprived. The post neonatal death rate in nonwhite, North Carolina infants in 1967 was 15.9/1000 live births compared with only 4.7/1000 live births in white infants. Influenza and pneumonia accounted for 5.2 post neonatal deaths/1000 live births in nonwhite infants in 1967, over four times the mortality rate in white infants (Levy, et al.). Studies on the incidence of meningitis (Parke, et al., 1972; Fraser, et al., 1973) and severe lower

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respiratory disease in the southeastern United States (Loda, et al., 1968) support the view that respiratory infections which cause relatively mild illness in middle class children can lead to serious life-threatening illness in socioeconomically disadvantaged children.

The health research program at the Frank Porter Graham Child Development Center is based on the belief that acute respiratory disease constitutes a major health problem for all children but is a particularly heavy burden on the disadvantaged child. The accumulating evidence that antibiotic therapy is of only limited effectiveness in preventing the severe neurologic sequela of meningitis is a dramatic example of the fact that it is better to prevent disease than to seek to cure it. Preventive medical services require less skilled medical personnel and result in less morbidity than curative medicine. However, to prevent respiratory illness and its complications, it is necessary that we increase our understanding of the etiology of respiratory disease and the pathophysiology of the complications of these infections. This includes a better understanding of the possible synergistic action of viruses and bacteria in the respiratory tract and a greater understanding of the host response to both natural infection and to vaccine administration, particularly in young children. As a final step there must be careful clinical trials of potentially effective vaccines.

A review of the role of one respiratory pathogen, Hemophilus influenzae type b, may help to illustrate the importance of respiratory disease as a cause of mental retardation, particularly in socioeconomically deprived populations.

Hemophilus influenzae type b is the most common cause of bacterial meningitis in children (Smith, D. H., et al., 1973a). In the antibiotic

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era the mortality from this disease has decreased from almost 100% to between 5% and 30% (Smith, D. H., et al., 1973c), but even with adequate antimicrobial therapy permanent central nervous system damage occurs in over 50% of survivors (Sell, et al., 1972a; Sproles, et al., 1969). In one study of 86 patients, 14% of the patients died, 29% had severe or significant central nervous system impairment, 14% had possible residual handicaps and only 43% were free of detectable handicaps (Sell, et al., 1972a). Even in children apparently free of detectable residual neurological handicaps from meningitis more detailed psychological testing suggests that these children are functioning intellectually below the level of siblings and classmates matched by age, sex, and social class (Sell, et al., 1972b). When extrapolated to the estimated 10,000 cases of H. influenzae type b meningitis each year in the United States (Parke, et al., 1972; Mortimer, 1973), the magnitude of the problem becomes apparent particularly when the documented incidence of H. influenzae type b meningitis currently is rising (Michaels, 1971; Smith, E. W. P., and Haynes, 1972).

Epidemiologic studies in Mecklenburg County, North Carolina (Parke, et al., 1972) and Charleston County, South Carolina (Fraser, et al., 1973) showed the attack rate of H. influenzae meningitis in black children was 3.5 to 4 times higher than that in white children. The greatest risk was in low income, black families living in rural areas. An infant in the poorest section of Charleston County has a risk of approximately 1 in 280 of developing H. influenzae type b meningitis in the first five years of life, the highest risk of any group noted (Fraser, et al., 1973; Fraser, et al., 1974). It is known that the highest incidence of H. influenzae

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meningitis occurs in children seven to twelve months of age and that 89% of cases occur between the ages of three months and three years of age (Parke, et al., 1972; Fraser, et al., 1973). In these populations the children at greatest risk have been defined in terms of age and socio-economic status.

One important area for investigation is the mechanism by which H. influenzae type b overcomes the host defense mechanisms in the respiratory tract, invades the bloodstream, and reaches the central nervous system. Carriage of the organism often does not result in disease, but carriage of Hemophilus influenzae in the respiratory tract is highest in the same age group that has the highest incidence of severe disease due to the organism (Turk, 1967). The studies of microbial interaction in the Frank Porter Graham Center are particularly relevant to that crucial stage in the pathogenesis of meningitis when Hemophilus influenzae invades the bloodstream from the respiratory tract.

Because of the failure of antibiotic therapy to prevent permanent central nervous system damage following H. influenzae meningitis, emphasis has shifted to the development of an effective vaccine. A vaccine prepared from purified cell wall of H. influenzae is now being tested in human clinical trials (Smith, D. H., et al., 1973c; Smith, D. H., et al.). If the present vaccine, or some modification of it, does prove effective in producing adequate levels of antibody to protect the human infant the problem will remain of reaching the population at highest risk, the very young and the poor, the groups most often not reached by existing health services.

The health research program at the Frank Porter Graham Child Development Center (FPG) has centered on the study of respiratory tract infections and

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their complications with special emphasis on those microbial agents that produce otitis media and meningitis. The research has been conducted in the FPG longitudinal population which was initiated with the admission of ten children in 1966. The population has now grown, with the addition of new infants each year, to include sixty children, the present age range being from six weeks up to eight years. Until September, 1972, the children admitted were distributed equally by race, sex, and socioeconomic group; since that time all new infants admitted have been from socio-economically deprived homes. Medical care has been provided as part of the center services and ill children are excluded from day care only with varicella and measles. The children are observed daily and those children with respiratory symptoms have their respiratory tracts cultured for viruses, mycoplasmas, and bacteria. The stability of the study population has permitted observation of the same children for extended time periods and longitudinal follow-up of the children from early infancy has permitted the documentation of respiratory infections by isolation and serology.

With the increasing numbers of preschool children in group day care there has been particular concern in the United States about the health hazards that might be created. In order to investigate the validity of this apprehension, studies have been done in the FPG longitudinal population to compare the important etiologic agents and the rates of respiratory illness seen in children participating in day care with respiratory illness studies performed on children receiving home care. In 224 child-years of observation of the FPG longitudinal population during the seven-year period (1966-1973) there was an average of 6.2 respiratory illnesses/child-year (Table 5).

Insert Table 5 about here

The highest rate occurred in infants under a year of age with an average of 8 respiratory illnesses/child-year. The rate dropped with increasing age so that children over 36 months of age had a rate of 5.1 or less respiratory illnesses/child-year. These rates are quite comparable to the illness rates recorded in the Cleveland, Ohio Family Study, a comprehensive health study which monitored illness in middle class families living at home (Dingle, et al., 1964). The only excess in the FPG group occurred in infants under one year of age. The Cleveland Family Study noted slightly less than 7 illnesses/child-year in this age group while the FPG group recorded 8.0 illnesses/child-year.

The effects of sex, race, income and family size on respiratory illness in the FPG population has been investigated. In 224 child-years of observation there was more total illness in females than males (643.7 illnesses/100 child-years to 584.5 illnesses/100 child-years); however, females had less severe illnesses than did males (7.9 severe illnesses/100 child-years to 11.5 severe illnesses/100 child-years). When race was studied there was a slight increase in total illness in whites over non-whites (666.7 illnesses/100 child-years to 598.4 illnesses/100 child-years). The effect of family income on total illness and severe illness demonstrated that there was more total illness in the higher income group but more severe illness in the lower income group (Table 6).

Insert Table 6 about here

Family size did not seem to be an important factor on the total number of illnesses of a child in day care (2 to 3 family members--603.6 illnesses/100 child-years; 4 family members--654.5 illnesses/100 child-years; 5 family members--562.9 illnesses/100 child-years; 6 or more family members--651.6 illnesses/100 child years).

Not only have the illness rates been similar to that recorded in the observation of children receiving home care but the types of agents isolated and their age and seasonal incidence have been similar to microbial isolates from children in home care seen in a private pediatric practice in Chapel Hill (Glezen, et al., 1971). Table 7 summarizes the respiratory pathogen isolations during the first five years in the FPG study.

Insert Table 7 about here

The overall isolation data suggest the importance of respiratory syncytial virus and the parainfluenza viruses, particularly type 3. They are even more important because of the frequency with which they are associated with lower respiratory disease. Respiratory syncytial virus and the parainfluenza viruses accounted for over half of the isolates from lower respiratory disease. Illness due to respiratory syncytial virus and parainfluenza virus type 3 usually was more severe during the first year of life which presumably always represented a primary infection. Immunity following these respiratory illnesses was very short with almost all the infants being reinfected during their second respiratory season, but the symptoms were usually less severe (Loda, et al., 1972a). An effective immunoprophylaxis administered at an early age against these agents could significantly reduce morbidity in young children in group

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day care; however, due to the short duration of immunity produced by these viruses the vaccine probably would have to be administered annually to provide continuing protection. The adenoviruses, enteroviruses, rhinoviruses and group A streptococci caused a significant amount of upper respiratory disease and Mycoplasma pneumoniae was isolated from this population on several occasions (Loda, et al., 1972b). Despite technologic advances of the past two decades in isolating respiratory pathogens, the etiology of a major segment of acute respiratory tract disease and the mechanism of complications remain undefined.

Certain respiratory disease syndromes in animals and birds have been shown to depend on interacting infectious agents, rather than single pathogens. Studies were begun in January 1972 to demonstrate the role played by microbial interaction in the pathogenesis of respiratory infections and their complications such as otitis media and meningitis. The children in the longitudinal population were cultured for viruses, bacteria and mycoplasmas every two weeks when well and at the onset of each illness. In preliminary evaluation of the microbial interaction study, computer analysis of microbiological and clinical parameters of 1187 cultures obtained at the time of acute respiratory illnesses were compared with cultural data from 1068 specimens obtained from the same children when well (Glezen, Collier and Loda, 1974). Illnesses were classified according to severity as follows: (1) lower respiratory tract disease accompanied by otitis media, (2) acute otitis media, (3) lower respiratory tract illness alone, (4) febrile uncomplicated upper respiratory illness and (5) afebrile upper respiratory illness. The results of microbiologic studies were correlated with the severity of illness observed and the age

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of the child and compared to the microbiologic data from the "well" cultures. The bacterial isolations included in the analyses were pneumococci, Hemophilus influenzae and group A streptococci. Pneumococci were recovered from 719 illness cultures and 513 well cultures; H. influenzae from 309 illnesses and 112 well cultures; and group A streptococci from 66 illnesses and 45 well cultures. The frequency of isolation of these bacteria, alone or in combination, with or without a concomitant virus infection was correlated with the age of the subject or the severity of illness and compared with the microbiologic data from well cultures by age of subject. Among the bacterial agents, the isolation of H. influenzae was best correlated with acute respiratory illness. The frequency of isolation was 26.5% from all respiratory illnesses compared with 11.1% from well cultures. The isolation rate was slightly higher (32.7%) from children with otitis media than from children with other diagnoses. The rate was only 6.0% for cultures from well children under three years of age which yielded a ratio of positive cultures of H. influenzae of 4.4 to 1 for ill and well children in that age group. The frequency of isolation of pneumococci was 61.6% from cultures of children with respiratory illnesses and 52.6% from cultures of children when well. When pneumococcus was the only potentially pathogenic bacterium isolated there was no significant difference in isolation rates between sick and well, by age or by severity of illness. However, when pneumococci and H. influenzae were found in combination there were significant differences (18.9% of illness cultures and 7.2% of well cultures). When these rates were examined for children under three years of age the ratio of the frequency of cultures positive for both bacteria from ill and well (5.2 to 1) exceeded that for H. influenza alone.

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The data obtained to date suggest an interaction between H. influenzae and pneumococci and possibly between this combination in the presence of a concomitant virus infection. These associations may come into focus more sharply when enough data have accumulated to look at the relation of specific virus and H. influenzae types to specific pneumococcal serotypes (Loda, et al., 1973). Studies to date would strengthen the original hypothesis that interactions among diverse microbial agents may be responsible for a segment of respiratory disease in children presently of unknown etiology and may be responsible for a major proportion of complications of acute respiratory illnesses which may include otitis media, pneumonia, meningitis and others.

Research has been performed at FPG on the development of virus vaccines for respiratory syncytial, parainfluenza types 1, 2, 3 and influenza viruses. The evaluation of a vaccine in a small population like the Frank Porter Graham Center permits the demonstration of spread and examination of the interaction of the vaccine virus with other microbial organisms that might also be in any open population. Studies such as these are essential before field trials of such vaccines can be contemplated.

Refinements of the countercurrent immunoelectrophoresis and latex agglutination test are currently being developed in the FPG laboratory. These are rapid methods of detection of H. influenzae b antigen in spinal fluid, serum, urine, empyema and pericardial and subdural fluid (Ingram, et al., 1973; Newman, et al., 1970; Smith, E. W. P., and Ingram). The goal of this research is to provide a test which permits a diagnosis to be made of systemic disease caused by H. influenzae b in 5 to 30 minutes and specific treatment to be started immediately.

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Respiratory tract infections usually do not result in death and tissue is not available for pathologic examination; therefore, experimental models have been developed in the FPG laboratory to explore the host response and to gain more insight into the pathogenesis of respiratory disease and their complications. The adult Syrian hamster has been used extensively in our laboratory for study of the pathogenesis of Mycoplasma pneumoniae disease (Denny, et al., 1971). This animal model is also being developed for study of respiratory syncytial virus and parainfluenza virus type 3 infections. The Syrian hamster will continue to be employed in the study of respiratory disease to gain information on the mechanisms of disease production, pathology produced and immunologic response in the animal.

An in vitro tracheal organ culture model has been developed for study of the interaction of individual microbial agents, isolated from children in the FPG population, with ciliated respiratory epithelium (Collier, et al., 1969; Collier, et al., 1971). Tracheal organ culture permits the maintenance in vitro of viable, differentiated, organized, respiratory epithelium from human fetuses and hamsters. With this model, tissue from a single fetus or animal can be used for control and test groups. Tracheal rings may be infected with a specific number of cloned respiratory pathogens, thus avoiding the effect of secondary invaders seen in in vivo animal models. This system has been demonstrated to be useful for study of bacteria (Denny, 1974), viruses (Hoorn, 1966), mycoplasmas (Collier and Clyde, 1971; Collier, 1972), and combinations of microbial agents (Reed, 1971). The model has permitted study of pathophysiologic alterations due to infection of the tissue with respiratory microorganisms by light, immunofluorescence and electron microscopy, and of metabolic changes through use of radio-labeled precursors of proteins, carbohydrates and nucleic acids (Collier and Baseman, 1973).

In order to prevent respiratory disease that leads to central nervous system complications we must gain a better understanding of the interrelationships between microbial agents forming the ecosystem of the respiratory tract and the mechanisms by which microbial agents injure and invade the respiratory epithelium. An understanding of the reciprocal relationships among different respiratory microorganisms may allow development of methods by which these interactions can be altered to benefit the human host.

In addition to studies of the etiology and pathogenesis of respiratory disease, the Frank Porter Graham Child Development Center health program is participating with the Division of Community Pediatrics in programs designed to improve health care delivery, particularly to disadvantaged rural families. The availability of improved health care methods does not mean they will be used by the families in greatest need of them. There is abundant evidence that disadvantaged families do not benefit fully from existing health care resources (Bergner and Yerby, 1968). The rate of immunization is disappointingly low, particularly with vaccines designed to prevent illness in the very young (U. S. Immunization Survey, 1973).

The Division of Community Pediatrics provides child care in three community health centers sponsored by Orange Chatham Comprehensive Health Services, Inc. providing care primarily to low income, rural, North Carolina families. The family nurse practitioner is the primary care provider to the young child in these clinics and these nurse practitioners are effectively supplying high quality care to children in rural areas under physician supervision (Greenberg, et al., in press). Recently the state of North Carolina has launched a program of family nurse practitioner clinics in other rural areas of the state. This program envisions the opening of ten new rural clinics a year. The family nurse practitioners

for these clinics are being trained in a University of North Carolina program that has significant input from the Frank Porter Graham Center staff and has major emphasis on the developmental aspects of child care. Nurse practitioners also have provided child care at the Frank Porter Graham Center for several years in an effort to improve the efficiency of health services to young children in day care (Peters, 1971).

One major need in achieving better health care for disadvantaged children is to enlist the cooperation of families. In the Orange Chatham Comprehensive Health Services, Inc. clinics the community health workers perform a major role in health education and outreach activities. The community health workers are members of the local community and they often communicate more effectively with families in the community than health professionals. An infant stimulation program available to all infants in the Orange Chatham program is now being developed. Community health workers will visit homes to demonstrate and encourage the use of the infant curriculum materials developed in the Frank Porter Graham Center. The merging of health and educational services delivery to infants may have important cost advantages.

In summary, the disadvantaged child is at particular risk of developing major health problems which will contribute significantly to his failure to achieve full physical, cognitive, and social development. Research, therefore, is needed to develop better tools such as vaccines to prevent acute illness, particularly respiratory illness. In addition, better methods are needed to deliver these services in an efficient and acceptable way to families. The health care program at the Frank Porter Graham Center is seeking ways that will both reduce the illness burden of these families and provide an efficient system for distributing a wide range of child

care services to the consumer including both health and educational services.

SUMMARY AND CONCLUSIONS

The Carolina Abecedarian Project is currently in its second year of operation. At present a maximum of 2000 plus pieces of information are collected on each child each year. This information ranges from the identification of specific microbial agents in the child's respiratory tract to the number of social institutions with which the families have contact. It is hoped that such a breadth of information will help to understand the high-risk child's development and to insure that he develops normally.

Because there is so much data already available it is impossible to do more than merely skim the surface in a publication such as this. Also the availability of this large quantity of data presents some important data management problems. In an attempt not to become swamped in a sea of unrelated data, we are currently establishing a comprehensive, open-ended computer system which will allow access to any portion of the data from a remote terminal. It is expected that this data system will be fully operational by the fall of 1974. One advantage of such a system is that it facilitates the productive collaboration of investigators from diverse disciplines. Through such collaborative efforts we hope that we will grow from a multidisciplinary project into one which is truly interdisciplinary. Through such collaborative efforts we hope to make a contribution to the knowledge of how to prevent the biological, social, and intellectual stunting that currently is all too frequently the birthright of our most disadvantaged children.

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Footnotes

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[2]The Home Stimulation Inventory (HOME) was developed by Dr. Bettye M. Caldwell and colleagues and was initially reported by Caldwell, B., Heider, J., and Kaplan, B. as a paper entitled "The Inventory of Home Stimulation" presented at the annual meeting of the American Psychological Association, September 1966.

Table 1

High Risk Index

Mother's Educational Level (last grade completed)	Weights	Father's Educational Level (last grade completed)	Weights	Family Income	Weights
6	8	6	8	1,000	8
7	7	7	7	1,001-2,000	7
8	6	8	6	2,001-3,000	6
9	3	9	3	3,001-4,000	5
10	2	10	2	4,001-5,000	4
11	1	11	1	5,001-6,000	0
12	0	12	0		

Other Indications of High Risk and Point Values

Pts.	
3	1. Father absent for reasons other than health or death.
3	2. Absence of maternal relatives in local area (i.e., parents, grandparents, or brothers or sisters of majority age).
3	3. Siblings of school age who are one or more grades behind age-appropriate grade or who score equivalently low on school administered achievement tests.
3	4. Payments received from welfare agencies within past three years.
3	5. Record of father's work indicates unstable and unskilled or semi-skilled labor.
3	6. Records of mother's or father's I.Q. indicates scores of 90 or below.
3	7. Records of sibling's I.Q. indicates scores of 90 or below.
3	8. Relevant social agencies in the community indicate that the family is in need of assistance.
1	9. One or more members of the family has sought counseling or professional help in the past three years.
1	10. Special circumstances not included in any of the above which are likely contributors to cultural or social disadvantage.

Criterion for inclusion in high risk sample is a score ≥ 11.

Table 2

Selected Demographic Characteristics of the
First Two Yearly Cohorts Admitted to the Abecedarian Program

Group	Mean Maternal IQ	Mean Family Income	Mean Maternal Education	Mean High Risk Score	Mean Maternal Age	Mean Number of Siblings
Group 1 Center (10 females, 4 males)	80.0	$1,964.28	10.14	19.78	19.7	.7
Group 1 Home (10 females, 4 males)	78.14	$1,428.57	10.43	21.2	23.93	1.6
Group 2 Center (7 females, 8 males)	85.78	$642.86	10.35	18.93	17.64	.14
Group 2 Home (8 females, 6 males)	85.57	$928.57	10.21	20.78	18.07	.36

Table 3

MANOVA of Home Stimulation Inventory and Selected Demographic Variables Comparing the Experimental and Control Group Together with a Random Sample

Tests of Significance Using Wilks Lambda Criterion and Canonical Correlations

Tests of Roots	F	DF HYP	DF ERR	p LESS THAN	R
1 through 2	7.382	22.000	98.000	0.001	0.918
2 through 2	0.543	10.000	49.500	0.851	0.315

Variable	F(2,59)	Mean Square	p Less Than	Standardized Discriminant Function Coefficients
Emotional and Verbal Responsivity of the Mother	10.414	31.496	0.001	-0.092
Avoidance of Restriction and Punishment	8.027	7.024	0.001	0.155
Organization of the Physical and Temporal Environment	13.812	12.663	0.001	0.174
Provision of Appropriate Play Materials	34.188	89.166	0.001	0.142
Maternal Involvement with the Child	27.393	49.157	0.001	0.278
Opportunities for Variety in Daily Stimulation	17.986	18.694	0.001	-0.033
Maternal Age	22.976	383.421	0.001	0.273
Income	41.733	125.437	0.001	0.436
Paternal Education	49.674	212.877	0.001	0.848
Density of Home Populations	9.350	2.567	0.001	0.138

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Table 4

Summary of Significant Differences in Mother-Infant Behaviors Comparing Experimental and Control Dyads

	Behavior	Experimental Group Means	Control Group Means	Level of Significance
1.	Child Vocalizations (duration in seconds)	137.3	50.3	$p < .007$
2.	Fuss/Cry (duration in seconds)	43.2	161.4	$p < .023$
3.	Child Interacts with Mother and Toys (duration in seconds)	568.9	329.7	$p < .060$
4.	Mother Interacts with Child without Toys (duration in seconds)	116.7	11.7	$p < .026$
5.	Mother and Child Vocalize Together in Same 10 Second Interval (frequency of intervals)	19.7	5.2	$p < .008$

Table 5. Frequency of Respiratory Illnesses by Age, Frank Porter Graham Child Development Center, November 1966-June 1973.

Age (years)	Number of Resp. Illnesses	Patient Years At Risk	Resp. Illnesses/ Patient Year
< 1	330	41	8.0
1	283	35	8.1
2	276	40	6.9
3	220	36	6.1
4	153	30	5.1
5	74	22	3.3
6-8	43	20	2.2
All ages	1379	224	6.2

Table 6. Effects of Family Income on Respiratory Illness.

	Severe Respiratory Illness	Total Respiratory Illness
Low	13.6 illnesses/100 child-years	528.8 illnesses/100 child-years
Middle	10.6 illnesses/100 child-years	593.9 illnesses/100 child-years
Upper	6.1 illnesses/100 child-years	680.8 illnesses/100 child-years

Table 7. Number of Isolations of Respiratory Pathogens From Children With Respiratory Illnesses, Frank Porter Graham Child Development Center, 1966-1971.

Total Illnesses Studied 996

Agents	Number Isolates	% of Illnesses With Isolates
Respiratory syncytial virus	43	4.3
Parainfluenza virus type 1	21	2.1
Parainfluenza virus type 2	28	2.8
Parainfluenza virus type 3	59	5.9
Influenza A2 virus	7	0.7
Influenza B virus	12	1.2
Mumps virus	16	1.6
Adenovirus type 1	16	1.6
Adenovirus type 2	40	4.0
Adenovirus type 5	31	3.1
Adenovirus - not typed	5	0.5
Enteroviruses	65	6.5
Rhinoviruses	41	4.1
Herpesvirus	6	0.6
Group A streptococci	53	5.3
Mycoplasma pneumoniae	6	0.6

Figure 1

Five Sources for Synthesizing Curriculum Objectives

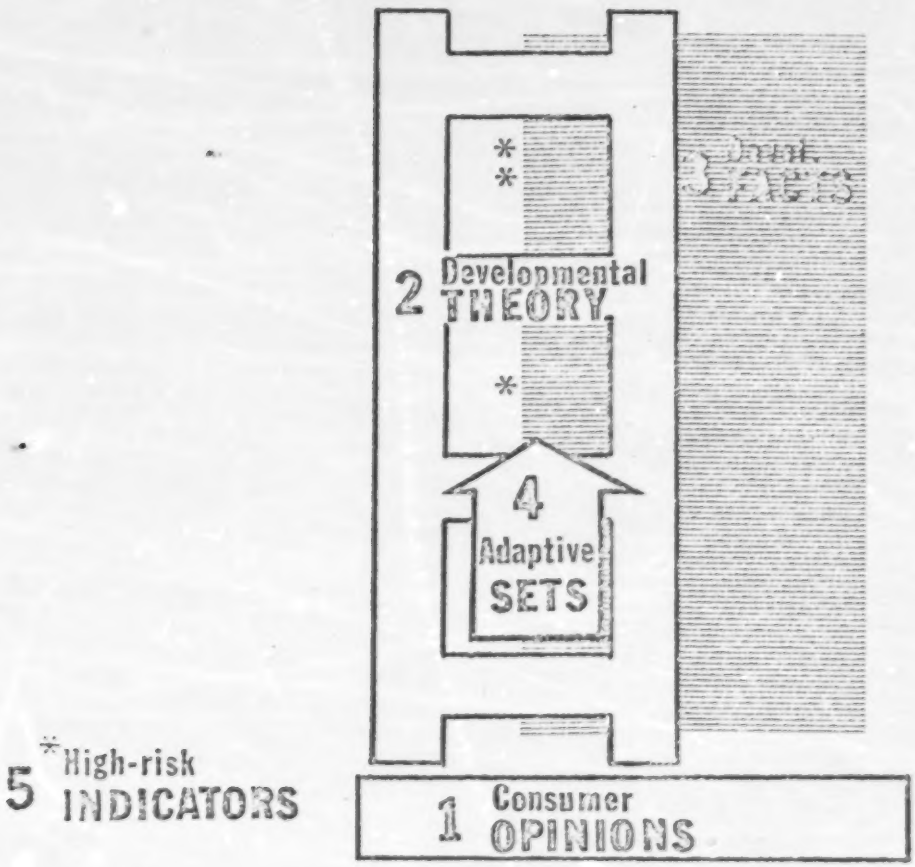


Figure 2

HOLDING THE BABY FOR A BETTER LOOK AT THINGS

HOW

* ADULT: Hold the baby to your shoulder. Keep your hand near his head but *let him support his own head for a few seconds.* Do this often when you pick him up. *Sit or stand so he sees something pretty over your shoulder.* Talk to him and stroke him as you hold him. Another person could stand behind you and talk to him.

* INFANT: The baby will hold his head steady for a moment then it will drop back to your shoulder. He will soon be able to hold it up longer and longer.

* EQUIPMENT: Picture or any colorful object.

WHY

* GOAL: To give him something to look at so he will want to hold his own head up.

* USES: The baby needs to be able to hold his head steady before he can learn to sit alone.

Figure 3

Holding the Baby for a Better Look at Things

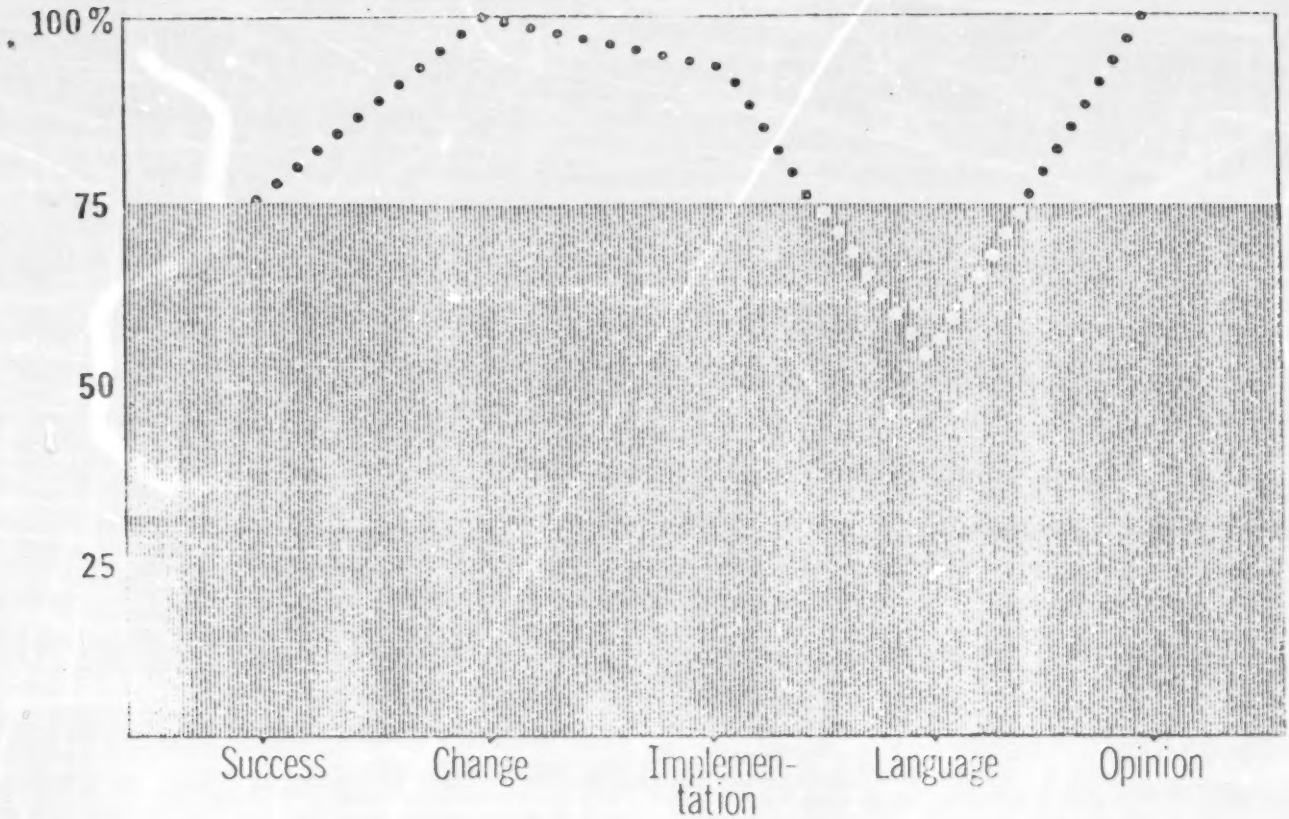


Figure 4

Choosing Between Big and Little

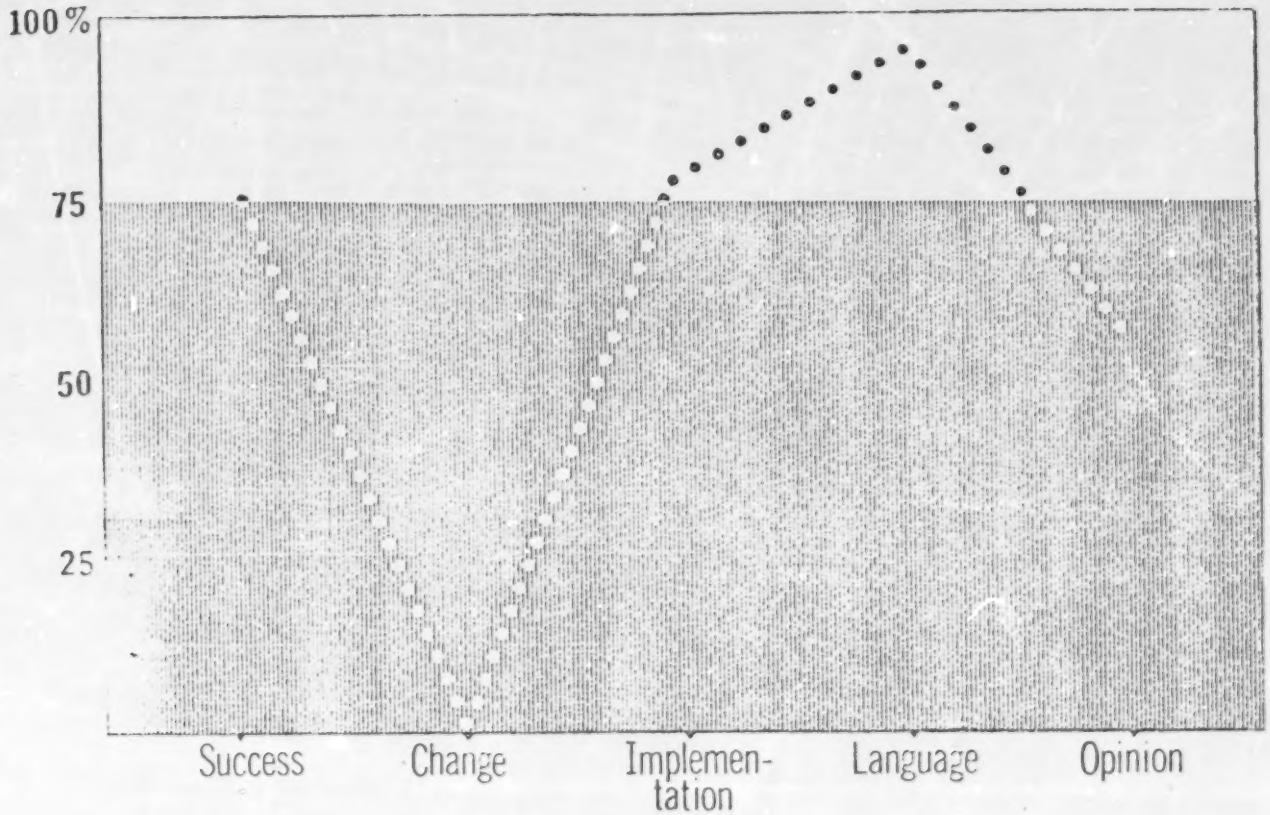
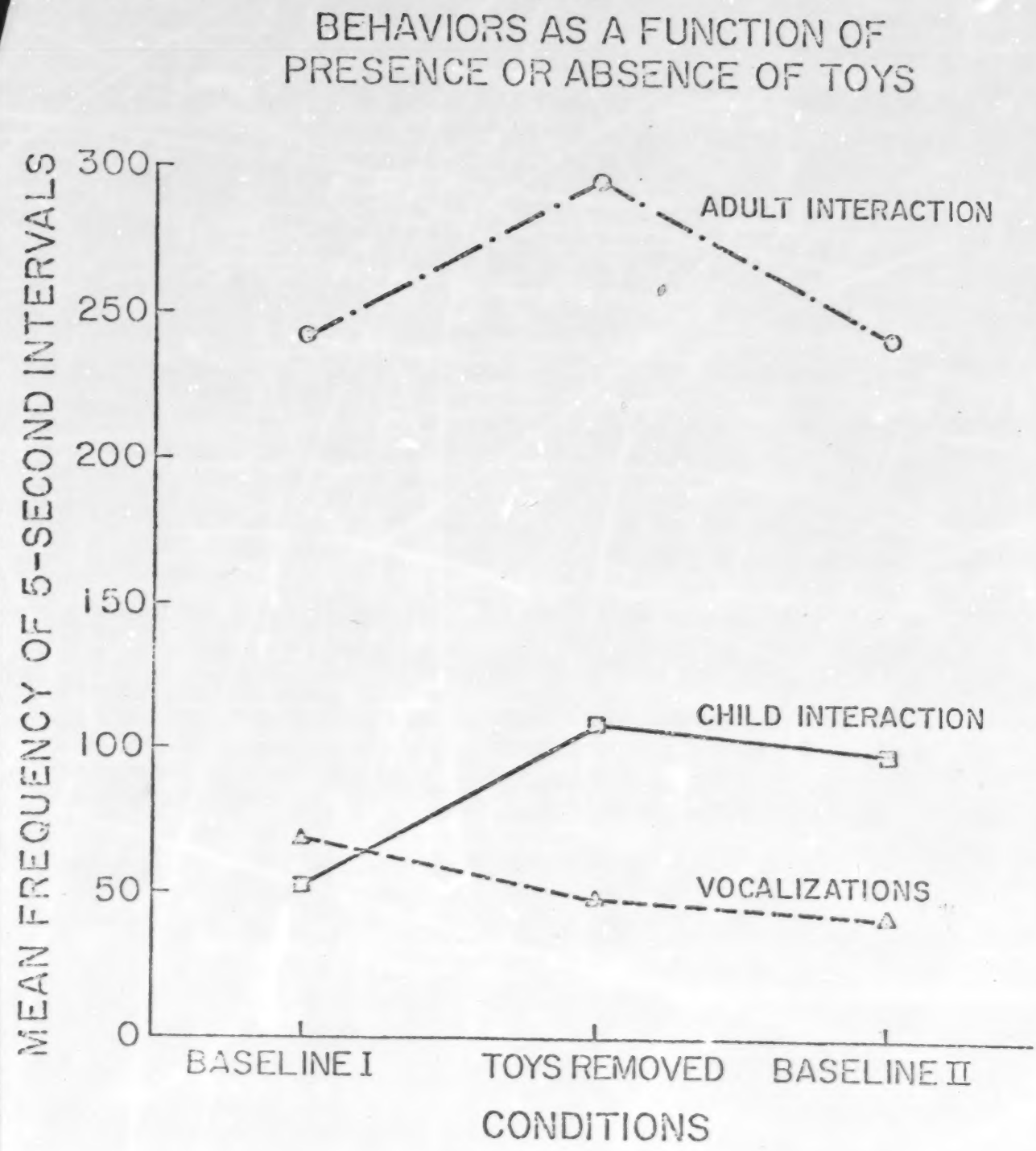


Figure 5


BEHAVIORS AS A FUNCTION OF
PRESENCE OR ABSENCE OF TOYS
MEAN FREQUENCY OF 5-SECOND INTERVALS
300
250
200
150
100
50
0
ADULT INTERACTION
CHILD INTERACTION
VOCALIZATIONS
BASELINE I
TOYS REMOVED
BASELINE II
CONDITIONS